# AERONAUTICAL AND ASTRONAUTICAL ENGINEER

**DESIGN AND EVALUATION OF A DIGITAL FLIGHT CONTROL SYSTEM FOR THE FROG UNMANNED AERIAL VEHICLE**

**Christopher H. Flood-Commander, United States Navy**
**B.S., United States Naval Academy, 1984**
**Aeronautical and Astronautical Engineer-September 2001**
**Advisor: Isaac I. Kaminer, Department of Aeronautics and Astronautics**
**Second Reader: Oleg Yakimenko, Department of Aeronautics and Astronautics**

The importance of unmanned aerial vehicles (UAVs) to current and future military operations cannot be understated. This rapidly developing field requires the ability to quickly develop and evaluate advanced control concepts. The FROG UAV serves as a test bed for advanced control and sensor projects at the Naval Postgraduate School. Previous control system projects have made use of a low performance electromechanical autopilot onboard the UAV. This autopilot imposed significant limitations on the responsiveness of the FROG. This project developed and tested an off board digital flight control system for use in lieu of the previous electromechanical device.

The digital flight controller was developed using the MatrixX rapid prototyping system and a previously validated dynamic model of the FROG. Surrogate flight control servo actuators were characterized in the laboratory and added to the plant model. Classic inner/outer loop controllers were developed for yaw damping and speed, altitude and heading control. The system was then successfully demonstrated with hardware in the loop in the lab.

The FROG was then instrumented and a command uplink latency of 170 ms was discovered. This introduced excessive phase lag into the system, which drove the flight controllers unstable. An alternate serial uplink method was developed and tested which reduced the command latency to 76 ms however the remaining phase lag resulted in limit cycle oscillation. Laboratory tests indicated that the current flight controller could withstand a maximum of 50 ms command path delay; without modification.